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BULLETIN OF THE
U.S. DEPARTMENT OF AGRICULTURE

No. 182

Contribution from the Bureau of Plant Industry, Wm. A. Taylor, Chief.
February 2, 1915.

(PROFESSIONAL PAPER.)

AGRICULTURAL ALCOHOL: STUDIES OF ITS MANUFACTURE IN GERMANY.[1]

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REVIEW OF THE PROBLEM OF MANUFACTURE.

INTRODUCTION.

The brandy (Branntwein) which in the fourteenth century was brought over the Alps from Italy to Germany found in the fifteenth century a competitor in a whisky (Kornbranntwein) which was made from cereals. The distilled fermented grape juice (wine) of

[1] Early in the fiscal year 1907–8 the Bureau of Plant Industry began an investigation of the problem of utilizing the waste and surplus products of American farms as a source for the manufacture of denatured alcohol. In view of the vast possibilities of this investigation, involving important questions not only of agricultural but likewise of economic and social import, it was deemed wise first of all to seek guidance from European experience. It seemed especially desirable to study the situation in Germany, where for a considerable period of time industrial alcohol from agricultural sources has been most conspicuously successful. Accordingly, arrangements were made to send Dr. Edward Kremers, of the University of Wisconsin, as special agent to visit those countries of Europe in which agricultural alcohol has been most prominently developed and to study as thoroughly as his stay would permit those factors likely to prove most important to America. As was anticipated, relatively little practical aid was obtained on the agricultural phases of the problem from England, Belgium, Holland, or France, and the greater part of Dr. Kremers' attention was given to the conditions to be observed in Germany.

The preparation for publication of Dr. Kremers' report was undertaken by Dr. Rodney H. True, Physiologist in Charge of the Office of Plant Physiological and Fermentation Investigations, of this bureau.

This report brings out the fact that the success of agricultural alcohol in Germany is the result of long-continued experimentation, backed by a determination on the part of those high in authority that the project should succeed. Private enterprise patriotically combined for this definite purpose rather than for private gain seems to have been a factor hardly less effective. The development of agricultural alcohol is found to be based on the principles of operation characteristic of manufacturing enterprises, and it bears little resemblance to the small farm enterprise to which many in this country have looked forward. Alcohol is seen to be not a separable source of income to the German landowner but a necessary factor in a large agricultural operation, the profits appearing rather in enhanced land values, larger yields of grain and forage crops, and in the dairy products made possible by the crops produced.

It is perhaps not to be expected that America can proceed along the same lines as Germany, but in our attempt to solve this problem of crops to afford light, heat, and power there is much of value in the German experience.—WM. A. TAYLOR, *Chief of Bureau.*

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the Mediterranean countries was replaced by the distillate of a fermented infusion (beer) from cereals of the more northern States. The consumption of the whisky became so widespread that restrictive measures had to be adopted by governments, not only for ethical and social reasons (Gildemeister and Hoffmann, 1899, p. 34),[1] but for economic reasons as well, it being feared that in years of poor harvests too large a quantity of the cereals might be withdrawn from their more legitimate use in bread making (Brockhaus, 1894, p. 501).

The first potato distillery was operated in Monsheim in the Palatinate as early as 1750, but the alcohol industry in Germany up to 1840 was based almost exclusively upon the use of cereals as crude material. The industry has developed primarily in the cities on a small scale (Kleingewerbe), and even as a side issue to other industries (Nebengewerbe). However, with the expansion of the cultivation of the potato—which gives a larger yield of starch per acre than the cereals—the distillation of alcohol became largely an agricultural industry. The western provinces of Germany with their more clayey soils were favorable to the cultivation of the sugar beet, whereas the light sandy soils of the eastern provinces (Brandenberg, Posen, and Silesia) were especially benefited by the cultivation of the potato. For this reason the distilleries in the western part are to-day primarily grain distilleries and are located at or near the cities. In south Germany (Baden, Wurttemberg, and Alsace-Lorraine) apples and other fruits, according to quantity of the crops obtained, are utilized in the distillation of alcoholic beverages. As in France, this industry, which is scarcely deserving of the name, is a home industry and is conducted on only a very small scale.

The agricultural significance of the development of the potato-alcohol industry as worked out in Germany is manifold:

(1) All of the ingredients taken from the soil by the potatoes are returned to the soil.

(2) The spent mash (Schlempe), which is the product obtained after the starch has been converted into alcohol and the latter has been removed by distillation, is a valuable feed for cattle. This enables the farmer to maintain a larger number of cattle than would otherwise be possible, and they in turn provide the manure so necessary for the light soil.

(3) The introduction of a cultivated crop (Hackfrucht) into the rotation has been of the greatest benefit, because it has made possible larger yields of grain even where the area devoted to cereal cultivation had to be reduced for the sake of the potato.

(4) Last, but not least, it has enabled the farmer to convert the unstable potato crop, especially of those varieties having poor keeping qualities, into a stable product, alcohol, which may be held as surplus stock for several years.

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[1] For citations to the literature, see the list at the end of this bulletin.

THE ECONOMIC SITUATION.

It would appear that as soon as the production of alcohol became an industry it was placed under governmental control. Not only for ethical reasons was this necessary, but for economic reasons as well. The fact that although alcohol as a beverage is not a physiological necessity, but that nevertheless there is a strong demand for it by man, makes it an especially opportune object for raising internal revenue. Under such conditions it is self-evident that the development of the alcohol industry in any country will be materially influenced by revenue and other legislation.

While the increased tax on alcohol used as a beverage placed a national check upon its consumption and therefore upon its manufacture, the rapid strides which have been made, especially in the improvement of the crude material, are directly attributed to the operation of a certain phase of the laws taxing the finished product.

MASH-CAPACITY TAXES, 1820 AND 1868.

The tax which up to 1820 was levied upon the still was in that year replaced in Prussia and in others of the North German States by a mash-capacity tax. To control the output of alcohol and to tax this directly was not considered feasible, although theoretically it was the simplest and most equitable method. Inasmuch as the ratio between the volume of mash, as made in those days, and the finished product was fairly well established, the taxation of the mash capacity, while indirect, appeared more equitable and fair than a tax on the distilling apparatus, a much more variable factor in the process of manufacture.

The average yield of alcohol about 1820 was computed at 2.5 per cent of the mash, a very low figure when compared with the results attained since then. Immediately, therefore, it became an object to the manufacturer to crowd as much fermentable material as possible into each unit of his mash-tub capacity. This was accomplished on the one hand by thickening the mash and on the other hand by choosing those potatoes which were richest in starch. As will be seen later, this second factor led to the general cultivation of potatoes richer in starch; and, since it was much to his advantage to secure the most complete fermentation possible, the distiller was led to a more careful study and manipulation of the yeast.

The inevitable result was that the original tax on the basis of a 2.5 per cent alcohol yield became antiquated and had to be increased gradually in accordance with the improvements made in the technology of fermentation. With each increase in the rate of taxation

a further incentive was given the manufacturer to improve the process as well as the material.

In 1868 the law regulating the mash-capacity tax, which had applied to Prussia and only a part of the other North German States, was extended to all of the States of the North German Federation.

From the following figures the development of the alcohol industry under this mode of taxation is readily shown. Previous to 1857, the year in which the Association of Spirit Manufacturers of Germany (Verein der Spiritus Fabrikanten in Deutschland) was organized, but few data are available. The low yield of 2.5 per cent, on which the rate of taxation was based in 1820, speaks for itself. In 1853, 5,962 distilleries were operated in Prussia (Meitzen, 1869, p. 553). Of these, 4,701 were located in the country and 1,261 in the cities. Within the same territory in 1907 there was but little deviation, the number of distilleries being 5,995 (Behrend, 1907, p. 395). However, the growth of the distilling industry can not be measured by the number of plants. For example, a reduction of the number of small stills in Bavaria and their replacement by larger, more rational outfits meant a positive advancement. A more correct indicator of the growth is found in the quantities of crude material used. For Prussia in 1855 and for the corresponding territory in 1905, the figures, expressed in pounds avoirdupois, are shown in Table I.

TABLE I.—*Potatoes and grain used for distillation in Prussia.*

Material used.	1855	1905
Potatoes.....pounds..	1,915,800,000	4,706,820,000
Grain.....do....	308,640,000	518,080,000

The consumption of potatoes, therefore, has increased 2½ fold during the past 50 years, and that of grain 1½ fold. In this connection it should also be remembered that the starch content of the potatoes has been increased.

The best indication of the growth, however, is found in the output of the finished product. Assuming an alcohol yield of 8 per cent in 1855—a rather high figure—Behrend (1907, p. 395) computes an output corresponding to 32,757,700 gallons (124,000,000 liters) of absolute alcohol. Figured on the same basis, the production in 1860 may be estimated at 42,003,825 gallons (159,000,000 liters) and in 1865 at 52,570,825 gallons (199,000,000 liters) of absolute alcohol. In 1907 the production of spirit in the German Empire exceeded 105,670,000 gallons (400,000,000 liters), and in the territory corresponding to the Prussia of the earlier days it exceeded 79,252,500 gallons (300,000,000 liters). The production of spirit since 1855,

therefore, has increased fully 2½ fold. If it be remembered that the percentage of yield assumed for 1855 was taken rather higher than was in all probability obtained on the average, this ratio becomes favorable.

TAXES ON THE FINISHED PRODUCTS, 1887.

While the tax on the mash capacity, therefore, had had a very beneficial effect on the technology of alcohol and on the industry as a whole, the legislation of 1887 had, at least at first, a very different effect. In addition to the mash-capacity tax, a tax was levied on the finished product when disposed of (Verbrauchsabgabe). This second tax was higher than the first and was graded according to the quantity of whisky produced. A certain amount (Kontingent), supposed to equal the consumption for beverage purposes established on the basis of the statistics of the previous period of 5 years, was taxed at the rate of 50 cents per gallon. The surplus alcohol above this estimated amount (Ueberkontingent) was taxed at the rate of 70 cents per gallon. The alcohol used for industrial purposes was not affected by this legislation, since the tax paid was refunded, as will be shown later.

The considerably increased price for whisky resulted in a corresponding diminution in the consumption. The amount consumed shortly before this law went into effect has been estimated at 79,252,500 gallons (300,000,000 liters) (Wittelshöfer and Behrend, 1906, p. 363), whereas in 1887 it dropped to 57,325,975 gallons (217,000,000 liters), that is, about one-third. In the long run it did not pay to produce more alcohol than the demand called for. A considerable reduction in the quantity of alcohol produced had to be the inevitable result. Such a setback to a most important agricultural industry was equivalent to a setback of agriculture at large. In this setback the South German States (Bavaria, Wurttemberg, and Baden) did not share to the same extent as the North German States, since this law applied only to the northern group. In order to persuade the southern States to accept the same taxation and to join the whisky-tax union (Branntweinsteuergemeinschaft), thereby making it effective for the entire German Empire, these States were given a more liberal assignment at the lower tax rate. As a result, the distilleries of these States produced but very little surplus alcohol; that is, practically all of their alcohol was taxed at the rate of 50 cents per gallon (50 marks per hectoliter) and but very little at 70 cents per gallon (70 marks per hectoliter).

The setback which was the immediate effect of the law of 1887 was, in part at least, counterbalanced by other effects which were the indirect outcome of the legislation. While the German distilling industry possibly never faced the problem of prohibition, the legis-

lation of 1887 clearly taught the lesson that the future growth of the consumption of distilled alcohol as a beverage would not be permitted to keep pace with the actual growth in population. Other outlets for the use of alcohol had to be sought, for the industry was greatly in need of expansion.

TAX REFUNDS ON INDUSTRIAL ALCOHOL, 1879 AND 1887.

The law of 1879 had already empowered the Council of the Representatives of the German States (Bundesrath) to grant the same refund of taxes on industrial alcohol that was granted to exported spirits. The first statistical data concerning the consumption of alcohol for industrial purposes date from this period. During the fiscal year 1880–81, 2,462,111 gallons (9,320,000 liters) were thus consumed. This quantity increased until in 1886–87 it amounted to 4,837,044 gallons (18,310,000 liters); that is, it had almost doubled in six years. Yet this amount is insignificant when compared with the drop in consumption of 21,134,000 gallons (80,000,000 liters), due to the tax levied on the finished product when disposed of (Abgabesteuer).

While the law of 1887 had introduced the heavy tax on the finished product, it also brought absolute relief from taxation of all alcohol for purposes other than as a beverage within the boundaries of Germany. The inconveniences which hampered the free use of the tax-free alcohol granted in principle by the law of 1879 were removed, and the completely denatured alcohol became as free as any other commercial commodity after 1887. Though the price of alcohol consumed for beverage purposes was greatly increased through the laws of 1887, the price of that used for technical purposes was lowered.

The results are best expressed in figures. As already stated, the quantity of technical or industrial alcohol used in 1886–87 in the States which were included within the whisky-tax union as constituted before 1887, was 4,834,402 gallons (18,300,000 liters). The quantity thus used immediately jumped to 8,215,842 gallons (31,100,000 liters) for this territory, and to 10,223,572 gallons (38,700,000 liters) for the entire German Empire.

INCREASE IN TECHNICAL APPLICATIONS OF ALCOHOL.

After 1887 there was a constant increase in the consumption of alcohol for technical purposes. However, an increase in consumption which would correspond to the demand for expansion was attainable only when this alcohol could be produced at a sufficiently low price. It was soon recognized that the most important field in which this consumption could be looked for was in its application to the production of heat, light, and power. Its use for the

production of heat was an old field in the application of alcohol. Alcohol burners and alcohol cooking apparatus had been used for a very long time. Its application for illuminating purposes and for generating power were, however, new. The courses to be pursued were indicated on the one hand by the invention of the incandescent mantle by Auer von Welsbach, in consequence of which such rapid strides were made in gas illumination, and, on the other hand, by the invention of the internal-combustion motor. However, in order to accomplish anything of real importance, the price of alcohol had to be reduced to such a point that it could compete with petroleum, the most widely distributed substance used for a like purpose.

DISTILLATION TAX OF 1895, AND BONUS ON INDUSTRIAL ALCOHOL.

The mere freedom from taxation did not suffice for the purpose desired. Other means had to be sought to attain this end. In consequence, there resulted the idea of the distillation tax (Brennsteuer), which was incorporated in the law of July 16, 1895. The distillation tax is a progressive tax on production, levied on the products of the distilleries. The revenues from this source are utilized for paying the refund (Rückvergütung); that is, a sort of premium or bonus paid on alcohol used within the German boundaries for other than beverage purposes. In other words, the money necessary for this cheapening of industrial alcohol was raised within the distilling industry itself. The effect of this distillation tax became apparent at once. Whereas the alcohol used for industrial purposes in 1894–95 amounted to 18,967,765 gallons (71,800,000 liters), in 1895–96 it amounted to 21,345,000 gallons (80,800,000 liters).

INCREASE IN POTATO CULTURE.

During the decade after the enactment of the law of 1887 the production of alcohol remained fairly constant. With one exception it varied little from 73,969,000 gallons (280,000,000 liters) a year. The exception occurred during the industrial year 1895–96, when the production rose to more than 79,252,500 gallons (300,000,000 liters). From the year 1897–98, however, the production of alcohol in Germany made enormous strides. As a result of the progress made in the cultivation of potatoes, harvests increased to an extraordinary degree. Those yields which formerly were regarded as enormously high were looked upon as barely average. From 1896 the potato crops increased annually until in 1901 they culminated in a harvest of 107,341,970,000 pounds (17,890,329,000 bushels), a yield that was attained a second time in 1905.

That this development should prove of consequence to the distilling industry was inevitable. The excess of potatoes naturally was

forced into the distilleries, thereby increasing the production of alcohol. This was made the more possible because the improved methods of cultivation were yielding potatoes richer in starch and the improvements in technology were causing a large yield of alcohol.

In 1897–98, 79,252,500 gallons (300,000,000 liters) of alcohol were produced, while in 1901–2 not less than 112,010,200 gallons (424,000,000 liters) were manufactured. Owing to the decrease in the potato harvests during the next few years, the production of alcohol dropped somewhat, but it reached its zenith in 1905–6 with a production of 115,444,475 gallons (437,000,000 liters).

For several years after the enactment of the law of 1887, the pecuniary success of the alcohol distilleries was not great. The price per gallon had dropped about 10 cents as compared with the prices obtained before 1887. The "Kontingent" did not afford a sufficient substitute for this reduction in price, since the large majority of distillers, at least in North Germany, were compelled to produce a considerable quantity of alcohol paying the higher tax rate of the "Ueberkontingent." To this must be added the fact that the distillers did not realize the actual average price for the year, but one considerably below the average. The prices of alcohol were fixed by the Chamber of Commerce of Berlin and were so regulated that they were relatively low during those months in which the alcohol was in the hands of the distiller, but they were raised as soon as the producers had disposed of their products. The result, therefore, was that the dealers and not the producers enjoyed the greatest pecuniary benefits from the manufacture of alcohol.

COOPERATION IN MARKETING.

It was soon recognized that relief would result only from a cooperative disposal of the alcohol produced. The basis for a cooperative union had been laid with the establishment and assignment of alcohol production under the lower rate of taxation (Kontingentirung). While attempts in this direction were made at once, they did not result in the desired success. In spite of the greatest efforts, a complete union of the entire industry did not immediately result. A number of provincial sale associations (Verkaufsgenossenschaften), cooperative organizations for the sale of alcohol, were organized, some of which still exist and constitute, as it were, the centers of crystallization about which the present large organization has developed for the disposal of the alcohol produced in Germany.

It was only with the third attempt, at a time when the position of the alcohol market had become untenable, not only for the agricultural distilleries (Brenner), but also for the distilleries and rectifiers in the cities (Spiritusfabrikanten), that these efforts were crowned with striking success.

ORGANIZATION OF THE CENTRAL ASSOCIATION.

In 1899 there was organized the Society of German Distillers for the Disposal of Alcohol (Verwertungsband deutscher Spiritusfabrikanten), which included not only practically all of the agricultural distilleries, but the most important of the city distilleries and refiners as well. The members of this new organization entered upon a preliminary contract for nine years with the Central Association for the Disposal of Alcohol (Zentrale für Spiritusverwerthung), which also was a new corporation, with limited liabilities, to which belonged almost all the rectifiers of alcohol. The members of the Distillers' Society (Verwertungsverband) pledged themselves to turn over to the Central Association for the purpose of disposal all of the alcohol manufactured by them. The Central Association in turn promised to dispose of the alcohol in the best manner possible, for a certain compensation which the members received primarily for the rectification of the alcohol thus obtained. The essential feature of the new cooperative organization was that the cooperating agricultural distillers would receive the full year's value for their product and that fluctuations in the price would no longer result exclusively to the benefit of the dealers.

On September 15, 1899, the new cooperative arrangement went into force. A limitation of the production of alcohol by contract was not contemplated. The peculiar nature of the agricultural distillation industry (Brennereigewerbe) did not lend itself readily to such a limitation. Besides, the position of those distillers who remained outside of the arrangement would have been strengthened, since these distillers would not have been subject to such a limitation. It therefore became apparent from the very beginning that the Society of Distillers would soon have to face the disposal of large quantities of alcohol, and that this disposal could not be sought in an increase of the amount of spirit used for drinking purposes.

The future of the distilling industry, therefore, lay first of all in the increased use of alcohol for technical purposes, and especially for those purposes to which petroleum was applied. The Central Association from the very beginning of its organization regarded the increase in this demand as its prime object. A special department, the technical section of the Central Association (technische Abteilung der Zentrale für Spiritusverwerthung), was created, having manifold duties. It was to test existing apparatus which had been constructed for developing heat, light, and power from alcohol; to establish stores in which such apparatus might be offered for sale to the public; to start a literary campaign for the application of alcohol to household needs; to send outfits to exhibitions; and to organize a retail trade in denatured alcohol, thus assuring the public that the

alcohol was of the required strength and that it could be had at a stable price.

Much has been accomplished in this way, and they do not assume too much who claim that what has been attained is due in the first instance to the Central Association and its technical division. But this activity, important and fruitful of results as it has been, could not have proved satisfactory without such a reduction in the price of alcohol as would allow it to compete with petroleum. Its sale at a price equal to that obtained for beverage alcohol was, therefore, not expedient; and a differentiation in the disposal of the product, according to the use to be made of it, had to be established. Inasmuch as it could not be assumed that any individual would dispose of his products except at the highest price attainable, such a differentiation could be accomplished only by an organization which, like the existing dealers' trust (Verwertungsunternehmen), could control the sale of the bulk of the alcohol produced. A large organization which exercises such control can do this, because the loss resulting from the sale of industrial alcohol at a lower price can be made up by the higher price at which alcohol consumed as a beverage is disposed of. Yet it was because of this differentiation in price between alcohol sold for technical purposes and alcohol used for beverage purposes that those who remained outside the Distillers' Society (Verband) enjoyed certain advantages. For example, they did not have to contribute to the sacrifices made on behalf of the alcohol consumed for industrial purposes. That such a situation should become a source of unpleasantness was but natural.

SUCCESS OF THE CENTRAL ASSOCIATION.

The striking success with which the activity of the Central Association has been crowned becomes apparent from a few statistical data. In 1898–99, the year in which the Central Association was organized, the consumption of alcohol for technical purposes amounted to 23,511,575 gallons (89,000,000 liters). During the first year of the existence of the association it rose to 26,153,325 gallons (99,000,000 liters), and by 1905–6 it had risen to 39,097,900 gallons (148,000,000 liters). The increase, no doubt, would have been much greater had it not been for the fact that the association had to pass through two crises: (1) In 1901–2, when the development of the technical consumption had to overcome the serious obstacle of the removal of the distillation tax, and (2) in 1904–5 when, in consequence of the failure of the potato crop, the retail price for denatured alcohol had to be increased. Nevertheless, in spite of the increased use of industrial alcohol, it became exceedingly difficult to establish an equilibrium between production and consumption

because of the enormously increased potato production. Indeed, the surplus of alcohol carried over increased from year to year.

VOLUNTARY REGULATION OF PRODUCTION.

In October, 1902, the surplus for which no use could be found amounted to 26,417,500 gallons (100,000,000 liters), approximately double the quantity that had to be carried over in any previous year. Something had to be done to diminish this surplus if a crisis which would affect the entire distilling industry was to be prevented. The consumption could not be sufficiently increased to reestablish the equilibrium, especially since the amount used as a beverage decreased rather than increased. Another measure, therefore, had to be resorted to, namely, the regulation of production. The agreement between the agricultural distiller and the association did not permit of such a regulation by contract. An appeal, however, to the agricultural distillers was not made in vain. The large majority of distillers realized that it would be more profitable for them to produce smaller quantities with reasonable profits than to distill large quantities at a loss. The representatives of 90 per cent of the agricultural potato industry voluntarily agreed to inflict upon themselves a reduction of 18 per cent, calculated on an average production for the years 1896–97 to 1900–1901. The result was that the surplus carried over the next fiscal year dropped to about 7,925,250 gallons (30,000,000 liters). The production agreement henceforth became a standard feature of the distilling industry.

The 9-year contract entered upon in 1899 between the Society of German Distillers and the Central Association expired in 1908, and the renewal of this contract for another nine years was accomplished. While the existing situation was thus assured, the distilling industry nevertheless anticipated the future with some curiosity if not anxiety.

THE POTATO THE PRINCIPAL SOURCE OF ALCOHOL.

The cultivation of the potato in Europe is of quite recent date when compared with that of grain, which has been cultivated two thousand years or more. Toward the end of the sixteenth century, the potato was brougnt from America to certain parts of Spain and Engiand. At first it was considered a curiosity, and for a long time attracted but little attention when cultivated in gardens. Gradually, however, the value of the potato as a nutritious food became known and its cultivation increased accordingly.

The great extent to which the cultivation of the potato was carried on in Prussia during the second half of the eighteenth century was due to the efforts of Frederick the Great, who appreciated thoroughly the great politico-economical significance of its cultivation.

In importance it no longer competes with the cereals; it exceeds them. Of 64,860,000 acres (26,250,000 hectares) of arable land in the German Empire, 8,150,000 acres (3,300,000 hectares), or 12.5 per cent, were planted with potatoes during the year 1901, a proportion which was maintained essentially unchanged during the five succeeding years. The cultivation of cereals was relatively slight, amounting in 1901 to 3,090,000 acres (1,250,000 hectares), that is, about 4.75 per cent of the total farming area.

Compared with all other civilized countries, Germany has the most extensive potato lands in proportion to both its area and the number of inhabitants. Table II shows the acreage of potatoes cultivated in various countries during the year 1900.

TABLE II.—*Area of potato lands in various countries in 1900.*

Countries.	Calculated on a total area of 100 acres.	Area grown for each 10,000 inhabitants.
	Acres.	*Acres.*
Germany	5.4	158.88
Austria	3.9	110.70
Hungary	1.8	75.60
France	2.9	97.36
Great Britain and Ireland	1.6	30.64
Russia	.7	81.54
United States	.1	34.10

For several years the potato crops of Germany have increased enormously, not only in the quantity produced on a given area, but also in the total amount, as is shown in Table III, covering the years 1896 to 1907, inclusive.

TABLE III.—*Potato crops of Germany for the years 1896 to 1907, inclusive.*

Year.	Area cultivated (acres).	Crop yield (bushels of 60 pounds).		Year.	Area cultivated (acres).	Crop yield (bushels of 60 pounds).	
		Total crop.	Per acre.			Total crop.	Per acre.
1896	7,543,444	1,187,875,000	157.5	1902	8,008,511	1,595,490,000	199.1
1897	7,580,440	1,241,040,000	163.7	1903	7,998,627	1,574,930,000	196.8
1898	7,612,158	1,349,250,000	177.2	1904	8,124,648	1,332,090,000	163.9
1899	7,737,845	1,414,100,000	182.7	1905	8,196,307	1,773,940,000	216.4
1900	7,953,598	1,491,220,000	187.5	1906	8,159,242	1,576,220,000	193.05
1901	8,200,834	1,788,920,000	218.1	1907	8,146,887	1,671,700,000	205.08

Longer periods of time likewise reveal an enormous increase in potato crops, as is shown by the following 5-year averages for a period of 20 years: From 1887 to 1891, 999,780,000 bushels; 1892 to 1896, 1,230,900,000 bushels; 1897 to 1901, 1,460,540,000 bushels; 1902 to 1906, 1,570,530,000 bushels. The increase in the average for the last period over that of the first period amounted to 570,750,000 bushels, or 57 per cent, representing a value in excess of $90,000,000.

The value of the potato crop in Germany is shown by the following figures, which give the average amount of raw food material produced by the various cereal crops from 1896 to 1901, as compared with potatoes: Rye, 14,726,738,000 pounds; wheat and spelt, 6,790,168,000 pounds; all grains, 21,516,906,000 pounds; potatoes alone, 19,246,158,000 pounds. It becomes apparent, therefore, that potatoes furnished but 10.5 per cent less raw food material than all the cereal products combined.

The potato crops gathered from land which was cultivated according to rational methods exceeded by far the average potato yield. According to statistics collected by the Association of German Distillers for the Disposal of Alcohol, there were harvested in some instances crops of more than 535 bushels per acre, while yields of 300 to 375 bushels per acre were quite common. While it is true that such crops as these were produced only by very intelligent agriculturists and under very favorable conditions, the possibility of attaining these results proves that the total yields will increase considerably in the future, for the experience which the pioneers in this direction have obtained in cultivating potatoes will naturally become common knowledge in the course of time.

Where the cultivation of potatoes is carried on extensively, it forms one of the best supports for rational methods of agriculture, especially where circumstances are unfavorable to the cultivation of the sugar beet. This is the case in the larger part of Germany. While potatoes require good soil and considerable manuring, the care in this direction is rewarded by large crops and an excellent condition of the soil for the next crop, whatever that may be.

The growing of largely increased crops has unfortunately one drawback, namely, the danger of overproduction. Inasmuch as it is not advisable to diminish the area cultivated except in special cases and in a limited manner, it becomes necessary to find outlets for the surplus.

For many years the popular method of utilizing potatoes has been as a crude material in the chemical industries. The most important ingredient, starch, is used either for the manufacture of pure starch or for the transformation into alcohol by means of fermentation after previous saccharification. The process culminates in distillation, in order to separate the alcohol formed from the other substances of the tuber.

In both cases the result is a product of almost unlimited stability, representing a high value in small quantities and providing an article easily convertible into money. The by-products of establishments working with potatoes furnish large quantities of nutritious feed, and therefore potatoes form a valuable crop when, in connection with the agricultural operations, the starch-making and distilling industries are combined.

Distillation is the more important and extensive of these two branches of agricultural industry. The manufacture of spirits is the only form of potato utilization concerning which we possess reliable statistics. It appears that with the increased potato production, the use of this product for the manufacture of alcohol has also increased. Behrend (1905, p. 30) estimates that in 1905, calculating on an average total crop of 1,578,530,000 bushels, 5.8 per cent of the crop, or over 90,000,000 bushels, were used in the manufacture of spirits. At first thought this quantity does not seem large, but it gains in importance when we consider to what extent the distillation of potatoes exists as an agricultural industry in the German Empire.

Many such distilleries are situated in the eastern part of Germany, the principal centers being in the Prussian Provinces, Posen, West Prussia, Pomerania, and Brandenburg. In these eastern regions the price of spirits regulates the price of potatoes. The fact that these agriculturists are accustomed to dispose of their surplus potatoes in the western regions, where the demand is greater than the supply, proves how important a factor such distilleries are.

When considered from another point of view the alcohol distillation becomes the more important as a branch of agriculture, since it alone renders a rational method of agriculture possible in those regions which possess a light soil and are situated, as most of them are, at a distance from business centers. Indeed, thousands of agricultural undertakings owe their existence to these distilleries.

About 6,000 agricultural potato distilleries are in operation in the German Empire, 4,000 of which represent one of the chief activities of the respective farms, whereas the remaining 2,000 have a secondary place.

The production of spirits from other substances, such as grain, fruit, and molasses, is insignificant in comparison with that from potatoes. During the year 1905–6, 115,629,397 gallons (437,700,000 liters) of pure alcohol were produced in distilleries of all kinds (Behrend, 1907, p. 401). Of this quantity, 92,947,035 gallons (351,800,000 liters) were produced in agricultural potato distilleries, representing over $36,000,000 as total receipts. This is calculated on an average value of about 39 cents per gallon, a price slightly lower than that of the Central Association for that year.

The spent mash, valued at 15 cents for a quintal of potatoes (220.26 pounds), must also be considered, since it represents a value of over $3,750,000. The total value of products derived from agricultural potato distilleries, therefore, amounted in that year to nearly $40,000,000 in gross receipts.

THE DISTILLERY AS A FACTOR ON THE MARKET.

It is generally admitted, even by ardent advocates of the agricultural distillery as an economic factor, that alcohol from the numerous agricultural distilleries costs relatively much more than the same article manufactured in the larger distilleries. This conclusion is the direct result not only of general observation, but also of careful computations made at the Institution for Fermentation Industries (Institut für Gährungsgewerbe). This is true in a measure of even the larger agricultural distilleries.

Even the casual visitor to the general agricultural distilleries, who knows nothing of technological computations, must be impressed with the correctness of this statement. Most of the estates have not more than a double operation (Betrieb), whereas a working day of 12 hours would admit of a fourfold operation. The efficiency of the plant, therefore, is but one-half what it might be. On an equipment of $40,545 (170,000 marks), or even of $19,080 to $21,465 (80,000 to 90,000 marks), this certainly is an important industrial factor. From the purely industrial point of view, therefore, taking into account the interest on the principal involved, the depreciation of the machinery but half utilized, and the cost of labor not fully utilized, the reason becomes apparent for the statement so often made, even by the strongest advocates of the agricultural distillery, that the distillery does not pay. It should be added, however, that whenever alcohol brings a better price, as was the case during the campaign of 1907–8, even this aspect of the situation is regarded as more hopeful.

However, the owners of estates would not maintain these distilleries if they did not pay in some way; new distilleries would not be built if they were regarded as losing investments, and the Government would not be justified in stimulating these institutions if they were not regarded as an economic factor of importance.

While, therefore, the question of the direct industrial value of these agricultural distilleries is a debatable one, the question of their indirect economic value does not seem to be questioned.

The extended cultivation of the potato—extended so largely for the very reason that the quantity produced over and above that needed for culinary and other usual purposes can be converted into alcohol—has made possible the profitable cultivation of large tracts of light, sandy soil in eastern Germany. One of the other principal uses to which this soil is put is that of forestation (pine), but although timber is very valuable in a way, it does not add to the food resources of the country.

Not only has the extended cultivation of the potato made larger tracts of land productive, but the land already under cultivation has been materially improved by the use of potatoes in the proper rotation of crops. Thus, for example, the yield of grain is increased

when potatoes are cultivated every third year. Since the potato demands deep cultivation this crop accomplishes for the eastern provinces what the sugar beet does for the heavier soils of the western provinces. Furthermore, the alcohol distillery makes possible the ready conversion of an unstable product into a stable one. At best, potatoes can be kept only until the warm weather of the next season sets in, whereas alcohol has been kept by the Central Association for several years following an overproduction. Besides, the potatoes can be sorted, as is done, for instance, in the neighborhood of Berlin, and the best can be put upon the market for eating, while the small and otherwise inferior ones—that is, those which are damaged or which reveal poor keeping qualities—can be taken to the distillery. Again, as soon as the potatoes show signs of decay the capacity of the distillery can be increased. Thus a large part of the waste of an important product of the farm can be saved, for even those potatoes which are already partly decayed can be utilized.

The spent mash—by far the most important by-product of the distillery—and the skins and watery wastes (Abwässer) are important adjuncts to the food rations of cattle. The cattle in turn furnish fertilizers to the soil, and are thus profitable aside from the pecuniary advantages derived from the milk and the meat. In order to fully appreciate the value placed on the manure, the by-product of the dairy barn, it is necessary to see with what scrupulous care it is preserved as well as with what large expenditure of time and labor the fields are manured.

Thus everything works hand in hand. After having seen all this, one begins to appreciate more fully why such an organization as the Society of Distillers for the Disposal of Alcohol, consisting almost exclusively of agriculturists, should be willing to spend so much money and energy in finding new industrial outlets for alcohol and for improving and popularizing the present outlets. This class are not trying to improve their situation by stimulating the consumption of alcohol as a beverage but by devoting their entire resources to the increased use of technical alcohol, as it is called. In this way they are not only helping themselves, but they are also striving to make their country independent of Russia and of the United States in so far as the use of petroleum is concerned. Besides, the rapidly growing population of Germany demands that every acre of land be cultivated as intensively as possible. It is interesting to note that whereas the agriculturists as a class show considerable foresight in this respect the average owner of an estate has not yet learned to stimulate the consumption of alcohol by using it for technical purposes on his own premises.

For the sake of convenience the agricultural distilleries of Germany may be classified into three groups, as follows:

(1) The larger distilleries on the domains, estates, and large farms.
(2) The small outfits on the small farms.
(3) The larger cooperative distilleries.

According to the Landwirtschaftlicher Kalendar for 1908, Part II, page 22, there were 14,356 agricultural distilleries in Germany during the season of 1905–6 as opposed to 791 nonagricultural distilleries, and 53,050 stills employed principally in the production of brandy; also 28 distilleries producing alcohol from molasses.

Table IV gives a detailed statement of the capacity of these different classes of stills and shows the total output of each class.

TABLE IV.—*German distilleries, showing their number, capacity, and output in 1908.*

Capacity classification, based on annual production, computed as absolute alcohol (gallons).	Number of distilleries.						
	Classified according to crude material principally consumed.						Total, all classes.
	Potato.		Cereals.		Molasses.	Other substances.	
	Agricultural.	Industrial.	Agricultural.	Industrial.			
0 to 13.2	445	3	4,466	6	.....	[a] 47,478	52,398
13.2 to 26.4	237	3	1,051	9	.....	[a] 3,068	4,368
26.4 to 52.8	192	3	516	7	.....	[a] 1,360	2,078
52.8 to 79.2	162	.....	252	5	.....	[b] 386	805
79.2 to 132	150	1	174	15	.....	[c] 294	634
132 to 264	167	2	148	41	.....	[d] 252	610
264 to 660	297	5	299	129	.....	[b] 131	861
660 to 1,320	404	2	342	114	.....	47	309
1,320 to 1,980	146	.....	214	72	.....	11	443
1,980 to 2,640	77	.....	115	32	.....	6	230
2,640 to 3,960	211	3	114	56	.....	4	418
3,960 to 5,280	236	1	80	40	1	5	363
5,280 to 7,920	381	1	120	49	1	4	556
7,920 to 10,560	256	2	58	38	.....	2	356
10,560 to 13,200	264	2	58	20	.....	1	345
13,200 to 15,840	255	.....	19	11	.....	.....	285
15,840 to 21,120	528	2	44	17	.....	.....	591
21,120 to 26,400	511	.....	22	10	1	1	545
26,400 to 31,680	448	.....	11	9	2	.....	470
31,680 to 36,960	341	.....	10	8	2	.....	361
36,960 to 42,240	252	1	7	4	.....	.....	264
42,240 to 47,520	149	1	4	5	1	.....	160
47,520 to 52,800	115	.....	3	4	3	.....	125
52,800 to 58,080	61	.....	2	4	3	.....	70
58,080 to 63,360	22	.....	1	6	.....	.....	29
63,360 to 68,640	22	.....	6	3	1	.....	32
68,640 to 73,920	14	.....	1	1	1	.....	17
73,920 to 79,200	8	.....	.....	2	3	.....	13
79,200 to 105,600	14	1	.....	13	3	.....	31
105,600 to 132,000	2	.....	1	7	.....	.....	10
132,000 to 158,400	.....	.....	1	5	4	.....	10
158,400 to 184,800	.....	.....	.....	4	1	.....	5
184,800 to 211,200	.....	.....	.....	3	.....	.....	3
237,600 to 264,000	.....	.....	.....	1	1	.....	2
264,000 to 290,400	.....	.....	.....	1	.....	.....	1
290,400 to 316,800	.....	.....	.....	1	.....	.....	1
316,800 to 343,200	.....	.....	.....	3	.....	.....	3
448,800 to 475,200	.....	.....	.....	2	.....	.....	2
660,000 to 686,400	.....	.....	.....	1	.....	.....	1
Total number of distilleries	6,367	33	8,169	758	28	[e] 53,050	68,405
Total production, computed as absolute alcohol....gallons	92,675,892	271,228	7,888,503	11,794,040	2,184,780	806,896	115,621,340

[a] Of these, 8 are industrial distilleries.
[b] Of these, 1 is an industrial distillery.
[c] Of these, 6 are industrial distilleries.
[d] Of these, 3 are industrial distilleries.
[e] Of these, 35 are industrial distilleries.

DISTILLERIES ON THE LARGER ESTATES AND DOMAINS.

A better understanding of the part which the distillery plays in the economics of the estate can no doubt be obtained from a few examples. For this purpose data bearing on the agricultural situation as a whole are here tabulated for three estates, two located in the sandy soil of the Mark Brandenburg, not far from Berlin, and the other in the Province of Silesia, in close proximity to soil sufficiently heavy for the cultivation of sugar beets.

TABLE V.—*Alcohol production on the larger estates of Germany.*

Item.	Estates.		
	Dahlem.	Dahlewitz.	Neuguth.[1]
Size of estate.....acres..	875	1,375	[2] 2,812
Area of potatoes cultivated.....do....	250	400	[3] 312
Average yield of potatoes per acre.....bushels..	187 to 213	266	267
Total yield.....do....	46,666 to 53,333	100,000	83,333
Used in distillery.....do....	13,333	33,000	50,000
Mash capacity.....do....	385.695	581.185	792.525
Operation (Betrieb).....	Twofold.	[4] Twofold.	Twofold.
"Kontingent" [5].....bushels..	10,825.892	([6])	12,152.05
Expected to be distilled.....do....	([7])	([7])	36.984.5
Cattle on the estate:			
Cows.....	210	100	100
Oxen.....	28	40	50
Calves.....	None.	Many.	150

[1] Does not include forest.
[2] There is an equal acreage of forest land. Of the 2,812 acres, 2,175 acres are under the plow, the balance meadow, lake, and garden.
[3] A larger area is cultivated with clover, lupine, and saradella; 60 acres with sugar beets, etc.
[4] Part of the time this distillery is expected to operate threefold.
[5] The amount allotted to the distillery in question.
[6] The "Kontingent" for this distillery had not been decided definitely.
[7] These two distilleries being located near Berlin, the managers themselves did not know how much would be distilled. Berlin naturally influences the potato market in the neighborhood much more than the market is affected at the more distant estates.

DISTILLERIES ON SMALL FARMS.

The large majority of the stills in Germany are used, as are those in France, for the production of alcoholic beverages from the juice of grapes, apples, prunes, etc., and not for the manufacture of alcohol as such. Practically all of the distilleries enumerated in Table IV under the heading "Other substances" are stills of this class. Their size and capacity can be judged, in large measure at least, by the annual output of beverage computed as absolute alcohol. Of the total 53,050 stills of this class not less than 47,478 have an annual output of only about 13 gallons of absolute alcohol. In other words, they produce 25 gallons of brandy of approximately 50 per cent strength or about 35 gallons of brandy of approximately 33 per cent strength. These distilleries, or more correctly the domestic stills, have nothing to do with the production of alcohol as such, and even where there are small distilleries for such production of alcohol, they are not considered even as a possible factor in the production of alcohol from

waste products on the farm. Such a use of small stills is regarded as financially impracticable even in countries like France and Germany, where the peasants have long since learned to live most economically and do not allow anything to go to waste.

There are, however, a number of small stills in Germany—large when compared with those just mentioned, but small when compared with the smallest distillery regarded as representing the minimum practical efficiency—which utilize potatoes and cereals for the production of alcohol as such and are maintained in large part for the purpose of supplying spent waste as forage for cows.

Several of these distilleries are still found in southern Germany. With the abolition of bondage during the early part of the nineteenth century, many of the peasants became small individual farmers. In parts of Bavaria, for example, the division of the larger tracts, both municipal and private, into diminutive farms resulted in the decimation of cattle because each farmer desired to cultivate as much of his land as possible. The result was that the land, no longer properly fertilized with stable manure, became more or less exhausted. To counteract this tendency, the cultivation of potatoes was stimulated by the installation of the so-called Pistorius distilling apparatus. Of these stills, mounted near the middle of the nineteenth century, some may yet be seen in operation. However, they are rapidly giving way to larger continuous stills and to a more rational mode of operation through cooperative means. In the village of Perlach, near Munich, where about 15 years ago there were 35 of these stills, but 4 were in operation at the beginning of the season 1907–8, and one of these was abandoned in December, 1907, the owner having purchased an interest in the local cooperative distillery.

Not only are these distilleries hampered in their operation because of their small size, but they are not continuous apparatus and hence involve considerable loss of time in charging (which is done with the aid of a bucket instead of a pump) and heating. Moreover, the men who operate these stills, although they may have had years of experience, have not, as a rule, a technical training. Naturally they can not undertake the production of the necessary yeast; hence, this must be obtained from the nearest brewery. This involves not only a loss of time, but it frequently means poor yeast and consequently poor fermentation. Even if the farmer be a man of somewhat greater intelligence than his distiller, he does not compute profit and loss and either he is satisfied to receive a certain amount of food daily for his stock and to receive money at regular intervals for his alcohol, or he listens to the agricultural lectures and abandons individual operation. The latter course, as already indicated, has become so common of late that there now remain but relatively few of these

small agricultural distilleries which actually produce alcohol as such. This should teach the lesson that false hopes should not be engendered in our farmers. Yet even these distilleries are not operated ephemerally, nor are they fed with what might properly be called waste material. They demand a constant supply of crude material and the constant attention of an operator, whose work often begins at 4 o'clock in the morning.

COOPERATIVE DISTILLERIES.

As already stated, the smaller distilleries engaged in the production of alcohol, not alcoholic beverages, are being replaced rapidly by cooperative distilleries. It is instructive to note at the outset one characteristic feature of the plan, namely, that the unit of cooperation is not expressed in shares having a certain money value nor in hundredweights of potatoes to be supplied, but in the amount of spent mash which the shareholder is privileged to call for daily. It is this feature of the cooperative enterprises which, possibly more than any other, clearly indicates where the value of the agricultural distillery lies, viz, in the maintenance of more cattle, which are so essential to the light, gravelly soils. This condition is found at Perlach, in the valley of the Isar, where one of the largest of the cooperative enterprises is located. A somewhat detailed account of this cooperative distillery is given elsewhere. Suffice it here to say that the contrast between a rational enterprise conducted on a scientific and economic basis and an irrational operation conducted by rule-of-thumb methods could not be greater than the contrast between this cooperative plant and the small still in one of the outhouses of a near-by farm. It should also be pointed out that cooperation in such a place as Perlach is made easy by the proximity of the farm buildings to each other, for the farmers of Perlach are for the most part village neighbors, who, while they work their outlying farms individually, follow their social instincts by living very close together.

REPORT OF VISITS TO AGRICULTURAL DISTILLERIES.

It was deemed wise in connection with this investigation to visit personally a number of agricultural distilleries representing the different types of conditions under which the problem of the production of alcohol has been worked out. Several estates were visited and such points of significance were noted as would be permitted by a single visit. It was clearly impossible to make exhaustive studies of these estates, but it is believed that the data obtained will prove of value.

DAHLEM.

The royal estate of Dahlem lies northwest of Berlin, between Steglitz and the Grunewald, a royal forest of more than 18,750 acres

(30,000 Morgen). It is one of the few of the numerous estates belonging to the State which are not rented or leased but are managed by the State itself. The new Botanical Garden has been created from a part of the original domain. The Pharmaceutical Institute and other public buildings have been erected on ground formerly belonging to it. Other parts have been sold to private individuals, so that at the time of the visit there was a colony of about 2,000 persons in Dahlem. Therefore, in view of the certain ultimate extinction of the estate by the ever-growing city of Berlin, it is natural that only such improvements should be made as are necessary.

The old homestead of the family of Wilmersdorf was erected in 1680 and now serves as a dwelling for the superintendent and as a bureau for the clerical force. The person highest in authority is the Wirklicher Geheimrath, an important government officer, who resides in a villa on the estate and who is an officer of one of the ministries.

For the reasons mentioned above this estate was of special interest because it shows what can be done under conditions by no means the most favorable.

At the time of the visit the area of this estate, aside from the large forest, comprised 875 acres (1,400 Morgen). Of this area, 315 acres were under rye cultivation, 252 acres under potatoes, 150.5 acres under oats, 94.5 acres under beets, and 63 acres under clover and other green forage crops.

The rye and oats were sold and the straw used as bedding for the cows, etc. The beets, of which there were several varieties, were used as fodder, especially in the winter, the leaves being fed in the fall. The clover and green forage crops were fed to the cattle.

There were 210 cows in two stables. For field work there were 14 yoke of oxen. There were 46 horses, 26 of which were employed in the fields, 18 were used to draw the milk wagons, and 2 were used for saddle purposes. Pigs, chickens, etc., were raised only for estate purposes.

Because of its proximity to Berlin, the estate was operated primarily as a dairy farm. On an average, 161.7 gallons of milk were obtained daily. Because of the absence of meadow lands no cattle were raised. Fresh cows were purchased, and after nine months or a year (monthly tests as to yield of milk being made) they were sold in a fattened condition to the butcher. In like manner the oxen were bought when young and after three years of service were sold in a fattened condition without loss.

The milk was delivered to retail customers in Berlin, and only in cases of oversupply, as, for example, during the summer months when the customers were away on their vacations and the sale of the

milk was therefore reduced, were the milk, potatoes, etc., sold to intermediaries. The profits, therefore, were not divided with any one except in cases of necessity.

As the production of the cereals serves two purposes, that of providing grain, which finds a good market in Berlin, and straw for bedding the cattle, so the potato also serves two purposes. The good tubers are sold, while the small and defective ones are kept for the distillery and ultimately furnish a by-product which is fed to the cattle.

Several varieties of potatoes are cultivated, with reference to the local market and with reference to their value as crude material for the distillery. Some of the table potatoes brought as high as 55 cents per bushel, others only half that sum. The average for the sorted product of the season of 1907 was about 44.4 cents per bushel. The summer of that year in Germany was cold and cloudy and was not very favorable for the potato crop.

The proximity to Berlin and the possibility of selling the better potatoes directly to the consumer act favorably on the price to be obtained. The smaller and poorer potatoes are valued, as crude material for the distillery, at 37.5 cents per bushel of 60 pounds. To this should be added 6.8 cents per 100 pounds, which is the estimated value of the spent material, as a cattle food.

The importance of the distillery as an agricultural industrial factor on this estate is readily indicated by its location. It was erected 25 years ago next to the old cow stable, and has a mash-tub capacity of 385 gallons. It was operated not with reference to reducing the cost of operation to a minimum but to spreading the production of the spent mash over as long a period as possible. Being an old distillery, it has but few modern improvements. Although it is equipped for a fourfold operation, it was operated only twofold, for the reason that while the Government allows the agricultural distilleries 249 days for operation, the allotment assigned by the Central Association to this distillery for the year 1907–8 was only 10,825 gallons of alcohol. On this quantity a tax of $12.50 had to be paid. On the excess distillation, that is, on all alcohol produced over this quantity, there was a tax of $17.50.

The 250 acres (400 Morgen) of potato land yielded on an average from 200 to 240 bushels of potatoes per acre, or about 50,000 to 60,000 bushels for the whole area. Of this total, about 1,850 bushels were used for table purposes on the estate.

When harvested, the potatoes were roughly sorted in the field. Those which were to be sold at once were shipped to Berlin, and the balance were stored in the fields, to be brought to the distillery as needed. The use to which these were to be put and the time

when they were to be used depended in part upon uncontrollable factors, such as their keeping qualities and the market price.

With this in mind, it becomes apparent why the distillery should have a fourfold equipment and also why at some times it should be run as a twofold operation and at other times as a threefold operation. These considerations also make it clear that for the sake of the cattle, as well as for the purpose of saving rotting potatoes, an excess distillation, on which the direct profits are greatly reduced, may be produced in a given campaign (distilling season).

To summarize: The Dahlem estate is operated as a dairy farm. Cattle are not raised, but cows and oxen are bought and as soon as their services cease to be remunerative are sold to the greatest advantage. Grain is cultivated with the dairy system in view. The straw is used for bedding cattle, and the grain (rye and oats) is sold in Berlin, while the flour for home consumption is bought. Barley, of which about 575 bushels are needed for malting, is not raised, because the yield on the sandy fields is said to be too low. Russian barley was bought for the campaign of 1907–8. Potatoes are cultivated and the distillery operated with the same end in view, namely, to provide warm feeding material for the cows during as many of the cold months of the year as possible. The production of alcohol, therefore, is conducted only as a side issue.

It is for this reason that the State has regulated the tax on alcohol as it has with reference to agriculture. A distillery operated like the one at Dahlem could not compete with a large modern plant in which the cost of production is reduced to a minimum. And yet the Dahlem distillery, small as it is, had as its "Kontingent" at that time four times the quantity assigned to what may be called the small agricultural distilleries, and more than the maximum for that class.

The small distilleries producing 10,000 liters (2,641.75 gallons) or less of alcohol pay nothing under the progressive tax (Brennsteuer). Indeed, the distillery at Dahlem, as well as all agricultural stills, does not pay this tax on the first 10,000 liters which it produces. On each additional 10,000 liters the tax increases. Only the mash tax is paid on the first 10,000 liters, and later, when the alcohol is released, if it is to be used for beverage purposes, the delivery tax (Abgabesteuer) is paid.

While each distillery has the right to hold back certain quantities of alcohol for technical purposes, this privilege is not exercised at Dahlem. The machinery operated on the estate is run by steam or electricity—by steam when such can be conveniently had from the boilers of the distillery, and by electricity when the cost of keeping up the steam would be too great for the services rendered. The prox-

imity of the estate to Steglitz makes electrical service convenient not only in the distillery but also in the creamery and in the grain shed for thrashing, etc. We have here an instance in which the most expensive kind of power is preferred, because it is cheaper for the service to be rendered than the power obtained from the alcohol manufactured as a by-product on the estate itself.

At the time of the visit to Dahlem the personnel of the estate consisted of 140 persons: Seventy "Einheimische," that is, such as are at home on the estate or in the neighborhood; and 70 "Auswärtige," that is, imported labor (largely Poles). There was a superintendent and three assistants. The superintendent is a sort of engineer who has general charge of the machinery. To this he can direct more of his time during the summer months. When the distilling operation is but twofold the distillations are ended by noon or shortly thereafter, so that his afternoons are available. When the operation is fourfold the working day lasts from 5.30 in the morning to 6.30 in the afternoon without interruption. It is estimated that the distillery is operated about 50 days.

DAHLEWITZ.

The station of Dahlewitz lies about 12 miles south of the Potsdam Belt Line Station of Berlin (Potsdammering). A 15-minute walk from the local station brings one to the former "Rittergut" or manorial estate.

At the time of the liberation of the serfs the original estate was partly parceled out. One-fourth was assigned to the village, another fourth to the former serfs, and the remainder, roughly estimated, constitutes the present estate. This was bought about 1879 for the present owner. At that time the distillery was reequipped, a large brick warehouse was constructed for grain, press cake, etc., and at the time of the visit a part of the old homestead was being rebuilt. It was said that the buildings on the farms, with their equipment, represented as large a value as that of the land.

The estate comprised 1,360 acres (550 hectares), of which, however, about 123 acres were leased to others. Of the remaining 1,237 acres, 1,114 acres were under cultivation, and 123 acres were used as meadow. These figures do not include the forest land belonging to the estate.

Of the 1,114 acres of cultivated land, 395 were for potatoes, 370 for winter rye, 247 for barley and summer oats, and 102 for clover, beets, etc. One acre of potato land yields about 297 bushels of potatoes, making a total of 117,315 bushels for the entire area cultivated. Of this amount, about one-third were small and defective potatoes, which were used in the distillery. Of the remaining two-thirds of the crop, part was sold, part kept for seed potatoes, and

part distributed among the workmen for use as food or to be fed to the pigs.

The grain for the most part is sold in Berlin, the straw being kept for bedding, etc. Whereas at Dahlem barley was not raised but had to be bought for the distillery, at Dahlewitz more than the quantity required for the distillery is raised, the surplus being sold in Berlin. In the malting process, oats are used with the barley in the proportion of 1 to 3. The grain is not mixed in this proportion at the time of malting, but when it is sown in the spring. It is believed that the natural mixture is better for the process of malting than the artificial mixture.

There were on the estate at that time 100 milch cows, 20 draft oxen, a considerable number of calves, 26 field horses, 6 coach and riding horses; also pigs and 300 chickens.

While the estate was run largely as a dairy farm it was by no means as exclusively such as the Dahlem estate. The cows were allowed to calve twice before being disposed of, the bull calves were sold when two weeks old, and the others were raised. Thus the stock was replenished on the estate. The calves were pastured for a part of the time, but the bulk of the 123 acres of meadow land was used for hay (Heuwiese). The cattle bred were the black Dutch.

All of the buildings looked very substantial, but the distillery, which was about 80 years old, was of a specially heavy construction. The interior was rebuilt about the time the present owner took possession. Most of the parts, therefore, are modern, and the general impression was very favorable, although naturally the arrangement is not as convenient as it might be, because it had to be adapted to the existing space. From the malting vaults to the receiving tank of the finished product everything had the appearance of order and cleanliness.

One fact observed was of special interest as showing the operation of the method of taxation. The agricultural distillery is still taxed in part in accordance with the mash-tub tax laws. This law has been regarded as of special benefit to the distilling industry because it stimulated a number of improvements, as, for example, the thick mash. In order to utilize the mashing space to the utmost, this distillery has a contrivance which removes the skins, etc., from the mash, thereby slightly reducing the volume. While such a contrivance would not be necessary in the United States, it shows how even in one of the smaller distilleries every step is taken to reduce the tax to be paid.

The capacity of the mash tubs is about 580 gallons (2,200 liters) per tub. About 500 tubs are fermented during the distilling season of 8½ months, using a twofold operation. About 1,215 gallons of spent mash are obtained daily, so that with 100 milch cows each cow

receives from 10 to 13 gallons of spent mash daily. The daily average yield of milk per cow is about 2.3 gallons.

Five men are employed in the distillery—one master distiller, one assistant, two laborers, and a fireman. The master distiller is also a sort of general-utility man, having general charge of all the machinery, the superintendence of the buildings, etc. Moreover, he must be something of an electrical engineer, as he also has charge of the dynamos used for both light and power, including field power. Here, as in Dahlem, no alcohol is used on the estate for technical or industrial purposes, electricity and steam being employed.

In this connection attention should be called to the electric railway operated on the estate. It has already been stated that it is about a 15-minute walk from the station to the estate buildings. These buildings are connected with the State railway by a track on which cars are hauled by an electric locomotive. Thus coal is brought directly to the distillery, and the alcohol, when released by the revenue officer, is hauled by rail in carload lots directly to Berlin, each car containing about 15 barrels having a capacity of about 119 gallons each.

Another matter of general interest is the system by which the accounts are kept. These are systematized, it would seem, by accountants of the agricultural society. Thus the dairy was charged with $2,875 for the previous year, including liberal items for fodder raised on the estate, for management, etc. If, on an average, 237 gallons of milk are obtained daily and 210 gallons are sold in Berlin at a little over 5 cents per quart (0.25 mark per liter), the income from this source may be estimated at $42 per day, to which should be added the price obtained for the fattened cows when they cease to be valuable for milking purposes.

According to the statement of the owner, the distillery in itself does not pay, but when it is regarded as part of the entire estate it does pay.[1] In the foregoing estimate of expenditures of the dairy business of the estate, the distillery receives a credit of 4.1 cents for the spent mash derived from every bushel of potatoes used.

The owner stated that in spite of the fact that the estate has 100 milch cows, 40 oxen, and 32 horses, besides calves, pigs, and chickens, he is still compelled to buy stable manure. In addition, he uses large quantities of artificial fertilizers, a fair-sized building being devoted to the latter. The soil about Berlin is very light and sandy, and evidently needs much stimulation to produce crops that it will

[1] Recently Prof. Delbrück warned against trying to introduce the manufacture of alcohol on too small a scale. In this connection he has figured out the cost of a gallon of alcohol when made in a small distillery and compared it with the cost of the same quantity when made in a large distillery. These figures, he said, were decidedly against the small distillery and were used by others as an argument against the agricultural distilleries. The justification of the small agricultural distilleries lies in their relation to agriculture as a whole.

pay to handle. Whether it would pay to raise grain so near Berlin without the tariff on cereals, the writer does not know.

The personnel of the estate of Dahlewitz consisted of about 30 men and 40 women. During the potato harvest 40 persons are added to this number, and during the winter it is reduced by 30 persons. During the potato harvest the children help the adults, who are paid for their work by the hundredweight of potatoes handled and not by the length of time consumed. In addition, the children are also employed during the summer afternoons to pull weeds. A number of families reside on the estate, and about 30 of the employed are outsiders (Poles, etc.).

DOMINIUM NEUGUTH-HEINZENBURG.

A 4-hour ride on one of the fast trains between Berlin and Breslau brings one to Liegnitz. If it were not for the pine forests most of the country southeast of Berlin would seem like a large sand waste from which people here and there are trying to make a bare living. It is really necessary to spend the larger part of a brief winter's day in traveling through this country in order to appreciate what has been accomplished, for example, at Neuguth.

From Liegnitz it is a good half-hour's ride by rail to Leuben, a quaint old Silesian town. From Leuben it is a 2-hour ride by wagon to the Dominium Neuguth-Heinzenburg. The dominium, having been enlarged by the purchase of ten small peasant farms (Bauerngüter), now comprises over 5,670 acres of land (9,000 Morgen), of which about 2,835 acres (4,500 Morgen) are forested, mostly with pine. Of the slightly larger area not forested, 2,205 acres (3,500 Morgen) are plow lands (Ackerland), 787.5 acres (1,250 Morgen) are meadow land (all hay), 25.2 acres (40 Morgen) are occupied by ponds or very small lakes, and 63 acres (100 Morgen) are garden land.

Diversified farming is practiced. During the season of 1907 the crops were as follows: Rye, 756 acres; potatoes, 315 acres; oats, 157.5 acres; wheat, 63 acres; barley, 63 acres; lupine, 220.5 acres; saradella,[1] 189 acres; clover, 157.5 acres; beets, carrots, etc., 63 acres.

The inspector, who had served an apprenticeship of five years with a scientific agriculturist from Halle, stated that he regarded 315 acres of potatoes a necessity in order to secure proper soil conditions for the necessary rotation of crops of the estate. Every third year cultivated crops (Hackfrucht)—that is, potatoes or beets—should be used. The result is that 350 pounds more of grain are harvested per acre. On the other side of Leuben, where the soil is heavier and admits of the cultivation of sugar beets, an increase of 525 pounds of grain is obtained.

[1] Saradella is preferred to lupine for light soil.

The average yield of potatoes was over 291 bushels per acre, resulting in a total of 91,660 bushels. Of this amount, 55,110 bushels were used for the distillery, 7,350 bushels were reserved as seed potatoes, 18,300 bushels were distributed among the laborers, 1,800 bushels were sold, and 9,100 bushels were used as feed. In the year 1907 the potatoes for the distillery were valued at 18.6 cents per bushel, including the spent mash. These potatoes were not sorted.

The new distillery, constructed by a Breslau firm after the plans of the building section (Bauabteilung) of the Society for Spirit Manufacturers in Berlin, cost about $42,500. The net profits in 1906 were $1,200, but the computation does not include the interest on the investment and a 10 per cent depreciation of machinery, due to wear and tear. According to the inspector the value of the distillery, therefore, lay in the utilization of the potatoes whenever desirable. This crop, however, as has been pointed out, is a necessary factor in the proper cultivation of the light soil.

The allotted output of the distillery is 12,150 gallons.[1] The mash-tub capacity is about 790 gallons with a twofold operation and with the possibility of a threefold operation. Eight gallons of spent mash are fed daily to each milch cow and about 59 gallons to the young stock. In addition to the spent mash, hay, etc., each cow gets the following ration: 1 pound of wheat husks, 1 pound of peanut cake, 1 pound of cottonseed cake, and 1 pound of sunflower cake.[2] As a result of this plan of feeding a daily average of over 2 gallons of milk per cow is obtained, averaging 3½ per cent of fat. The milk is sold to a dairy which pays in accordance with the fat content.

About 660 gallons of milk are used on the estate, and about 50,190 gallons are sold to the dairy in Polkwitz (about 4½ miles distant) at an average of 2.5 cents per quart. The owner, who is also one of the principal stockholders of the dairy, receives between $200 and $225 in dividends as additional profit.

In addition to the 100 milch cows there were on the estate 150 head of young cattle, 50 draft oxen, 40 horses, 500 sheep, 100 chickens, and 100 geese. Pigs are kept on the estate only by resident servants. The value to the estate of these numerous animals can best be appreciated if one sees what quantities of manure are spread over the fields. The carting is done by the men and the spreading by the women and girls.

[1] Formerly it was 15,850 gallons, but it was diminished because of the erection of new distilleries. This increase in the number of agricultural distilleries would seem to indicate that the estate owners are convinced of their value, even though the benefit derived be but indirect, at least in certain years.

[2] These materials are now purchased through a large corporation, an agricultural concern with headquarters at Berlin, which not only has branch depots in all large railroad centers but which also controls both price and quality by having analyses made. This cooperation has proved a serious loss to certain traders but is of benefit to agriculturists.

To judge accurately and in detail the agricultural value of these estates might be difficult even for an expert agriculturist. However, a layman can see what is being done on such an estate and can comprehend the difference between the fields which are carefully fertilized and cultivated and the broad sand wastes through which one passes by rail. But these estates are not merely farms—that is, they do not serve agricultural purposes solely. They are the homes of the nobility, at least in great part, and while some of the nobility no doubt are good agriculturists, others (and even the good agriculturists themselves) regard their farm profits as secondary to game preservation. This was well illustrated by conditions seen at Neuguth.

This was the first of the estates visited by the writer on which he found that at least a small part of the alcohol produced was used industrially. The owner has a high-speed automobile which he runs with alcohol, and in this way more than 1,000 gallons (4,000 liters) are consumed annually. The castle, the distillery, the wagon barn, the cow stable, the saw mill, and the carpenter shop, are lighted by means of alcohol. The distillery has an alcohol motor for pumping water and for running the grist and flour mill during afternoons when the steam is kept low and also during the summer months when there is no steam. The alcohol consumed on the estate annually exceeds 5,000 gallons.

TREBEN.

The Dominium Treben, owned and managed by Baron von Leesen, is about an hour's ride by wagon from Lissa, in the Province of Posen. Schwetzkau, a large village with a post office, maintains communication with Lissa by mail coach. The Province of Posen is that part of the former Kingdom of Poland which in the partition of that State was assigned to Prussia.

The soil appears to be of a somewhat heavier quality than that of Neuguth, corresponding possibly to that found beyond Leuben, since it admits of beet cultivation; but evidently it is much lighter than the soil of the typical beet sections to the west of Berlin toward Magdeburg.

In the absence of the inspector the superintendent of the distillery acted as guide. He also serves in the capacity of paymaster and subinspector at Treben. The inspector has general charge of the two estates, Treben and Petersdorf, which together constitute the "dominium."

The data which were obtained were given by the superintendent.

The distillery was erected at a cost of between $19,000 and $21,500, and was completed in 1906. Although not as fine a structure as the

one at Neuguth, it was equipped very much along the same lines, having been built by a Westphalian firm in accordance with plans and specifications provided by the building-technological division of the Society of Spirit Manufacturers. In completeness of detail it was not as perfect as the one at Neuguth, but it showed that a fine, up-to-date distillery can be built for little more than half the cost of the one in Silesia. The mash-tub capacity is about 792 gallons per tub and the operation a double one. For each operation 110 bushels of potatoes are used, making a daily consumption of 220 bushels. The spent mash (about 1,500 gallons) is fed to the cattle at Treben and Petersdorf.

The distillery had no allotment, but received a rebate for 264 gallons. During a run of six or seven months under the double operation they expected to distill about 26,400 gallons of alcohol. None of this was used technically on the estate. The employees of the distillery consisted of a master distiller and three assistants.

The two estates of Treben and Petersdorf comprise about 1,575 acres (2,500 Morgen) of cultivated land and the same area of wooded land. On the two estates about 20 men and 50 women are employed. During the summer months there are 15 additional laborers (Galicians).

At Treben there are about 60 milch cows, 16 draft oxen, 14 horses, and from 160 to 180 pigs. The number of animals at Petersdorf was not ascertained. The young cattle are kept there in addition to some milch cows. The potato waste from the distillery is fed exclusively to the cattle, the pigs receiving raw potatoes as part of their food. The amount of milk and the price received therefor were not ascertained. The bulk of the milk was hauled to the dairy, a distance consuming about two hours.

Here also the distillery was not regarded as a paying institution in itself, but its indirect value was twofold:

(1) It put the dairy on a better financial basis, because the cows and oxen after having served their purpose were in fine condition to be sold. The cattle were also a necessity because of the manure they furnished.

(2) The potatoes in this case were more valuable when converted into alcohol than when sold as potatoes. In the fall of 1907 they were valued for alcohol purposes at 17 to 18 cents per bushel, whereas in the market they brought only 9 to 10½ cents per bushel of 60 pounds and had to be hauled a considerable distance. The potatoes in turn were needed for a proper rotation of crops.[1]

WEIHENSTEPHAN.

The estate of Weihenstephan is the seat of the Royal Bavarian Academy for Agriculture and Brewing. It is located just outside the village of Freising, in Upper Bavaria. Its new experimental

[1] Beets were also cultivated, but they had to be hauled to the nearest sugar factory, a distance consuming about two hours' time.

distillery is equipped with two distilling outfits: (1) A modified hand equipment—that is, a still ordinarily operated without machinery, such as pumps, etc., and therefore of necessity interrupted after each operation—and (2) a modern equipment on a larger scale. Even this, however, is smaller than a minimum-efficiency apparatus should be in accordance with the computations of the engineering department of the Institute for Ferment Industries at Berlin.

In order to get the Bavarian distillers to adopt the plan of alcohol allotment, various concessions had to be made. Therefore, they occupy a favored position of which the northern distillers are envious. They are also permitted to utilize maize (from the Balkan States) whenever the potato crop is insufficient. They are, therefore, not agricultural distillers in the strict sense of the legal definition of this term as used in Prussia. Moreover, it has been the tendency of the State governments to favor the small distillers in proportion to their smallness. Whereas in the northern States and Provinces the hand equipment has been replaced almost entirely by mechanical operations, in Bavaria there are still a number of small distilleries. This appears to be due to two or three factors, namely, to the large number of small farms and to the conservatism of the farmers.

At the close of the eighteenth century the central Government of Bavaria permitted the villages to dispose of their communal property in small parcels to the villagers, a policy which was also adopted by other German States, but in no State was this process carried out in so short a time as in Bavaria. The result, from an agricultural and economic point of view, was very detrimental. A single instance may here be mentioned. Large tracts of land formerly used as meadow were placed under cultivation, and in a short time the cattle of Bavaria were literally decimated. The reaction on agriculture as a whole was harmful.

As an indirect outcome of this condition, the Bavarian system of agricultural education during the period near the middle of the nineteenth century lagged far behind that of other German States, although at the beginning the Bavarian Government had made a good start in the education of the newly created farmers. A hundred years ago their education by means of bulletins, etc., was out of the question, because the large majority here, as in many other places, could not read. Systematic education was even less possible. Therefore, education by example had to be resorted to, but even then the farmers availed themselves so little of the opportunity that at Weihenstephan it was abandoned for a time.

This condition of affairs not only explains why there are so many small distilleries in Bavaria, but it also explains the attitude of the scientific institutions which constitute their technical advisers. Side

by side, therefore, with a rational modern equipment one finds in the experimental distillery at Weihenstephan a modified hand equipment—that is, a small plant run in part by machinery and with a still operated by steam and not by direct fire. The object of this equipment is not to encourage the farmers to introduce even this improvement on their antiquated equipment, but to demonstrate that with their inefficient system of management they secure only a part of the alcohol which they ought to get. Even when this modified plant is operated under the most favorable conditions imaginable, the maximum yield on the average is but 10 per cent, instead of 12.

In addition to this small apparatus, the new experimental distillery is equipped with an outfit which has a mash-tub capacity of 275 gallons, worked on the single-operation basis. A threefold operation is possible and would be more rational.

PERLACH.

Perlach is a village 10 miles southeast from Munich, lying in the same broad valley in which that city is located. The Bavarian Alps, 30 miles to the south, form a beautiful panorama. The valley is covered with but a thin layer of soil, beneath which is gravel.

The light soil about Munich is especially adapted to potato cultivation, the Freising edible potato being especially esteemed. This soil needs considerable manure, which accounts for the fact that the development of the alcohol industry about Munich since 1850 has been in connection with the dairy farm and with the cultivation of potatoes.

Perlach afforded an especially favorable opportunity for studying in a practical way the conditions in Bavaria. The distilleries here found were of three classes: (1) Four small distilleries (the so-called fusel distilleries), (2) three medium distilleries with stills operated by steam rather than by direct fire, and (3) one cooperative distillery (Genossenschaftsbrennerei), the largest in Bavaria. These three classes, therefore, which mainly come into consideration in Bavaria, could here be studied side by side, which was exceedingly satisfactory, because a direct comparison under like conditions was thus made possible. Had they been separated by only a short distance, minor factors might have entered which would have been difficult to balance properly.

One of the four fusel distilleries was visited first. Concerning the estate on which this distillery was located a number of details were secured. The farm consists of 84 acres of plowed land (100 Tagewerk) and somewhat less than 33 acres (40 Tagewerk) of meadow and forest. About one-third of the cultivated area, that is, 25 acres, was planted with potatoes, the harvest of the previous season having

amounted to somewhat less than 5,512 bushels (1,000 Scheffel). All of the potatoes except those reserved for the house and for seed purposes were used in the distillery. One large structure serves as home, barn, granary, etc., but the distillery is in a separate building. The equipment dates from 1848 and is of the Pistorius type. Work began at 2.30 a. m., and the pay was $2.38 per week with meals while at work. The season began in September and was supposed to last until May.

About 20 bushels of potatoes were used each day. After being steamed they were mashed in a hand mill, the saccharine fermentation was started with malt prepared in the cellar of the house, and the alcoholic fermentation was started with brewers' yeast. The capacity of the three tubs amounted, respectively, to 246, 272, and 248 gallons. The yeast, which was kept in a large vat outside the building, looked more like the liquid in a manure pit than like any well-prepared or preserved yeast. From the fermenting vats the mash was lifted by means of buckets into a trough which carried it to a warming apparatus (Vorwärmer). This in turn served to condense the water from the still, thus concentrating the spirits. The large flat still was heated with direct fire. The distiller's book showed that the average yield of alcohol was from 5 to 7 per cent. The strength of the spirits obtained was from 48 to 50 per cent. Two revenue officers, who were visited later, stated that 5 per cent was rarely, if ever, obtained, at least in their district.

The waste material went to the barn, where it was fed to the cattle. At that time 20 milch cows and 5 oxen were being fattened. About 150 to 160 pounds of milk a day were obtained, which sold for 3.6 cents per quart to the milk seller, who peddled it in Munich. Potatoes were valued at the cooperative distillery at 19 to 20 cents per bushel. Alcohol sold at 61 cents per gallon, with a tax of about 9.9 cents per gallon.

As to whether the distillery paid, the distiller had no idea other than that the spent mash or waste was necessary for the cows. That the same by-product could be had from the cooperative distillery he evidently did not consider.

Of the medium-sized distilleries only one was visited. The farm on which it was located had about 247 acres of cultivated land. There was a very large building, which served all purposes from a dwelling for the family to a stable for the animals, and it all made an excellent impression.

On the whole, the conditions on a large farm differ but little from those observed on the small estates in the North. The main difference is probably that the proprietor himself works with all the members of his family. The distiller on this farm had no assistant, but

possessed sufficient technical skill to prepare the yeast himself. He claimed to obtain a yield of 10 to 11 per cent of alcohol, which compares very favorably with that of the smallest distilleries. The strength of the alcohol obtained was about 90 per cent, somewhat lower.

The cooperative distillery at Perlach has existed as such since 1886. The distillery itself was erected and equipped in 1880 by private means at a supposed cost of about $95,400, and was purchased by the cooperative corporation in 1886. A share in the cooperative society consists in the right to draw 264 gallons of spent mash, and represents a stock value of about $600. There are 20 of these shares, representing a total stock of about $12,000. The plant was bought for about $28,620, there being an original indebtedness of about $16,600. The actual value of the plant was said to be four times the sum paid for it, but the stock had not been watered, neither did the books of the company show a higher value. Premiums were paid in a semiprivate way.

While there can be but 20 shareholders, a share may be divided among two or more persons, only one of whom, however, can be the actual shareholder, the others being associates. Thus, the smaller farmers were enabled to take a part share, the total number of participants at that time being 36, some of whom had only a tenth of a share. For each tenth in which a farmer participated he drew 26.4 gallons of spent mash, as already indicated. Potatoes were bought outright. During that season the prices fluctuated but little, lying between 19 and 26 cents.

The mash capacity of the distillery is 1,268 gallons per tub. The allotment admits of a threefold operation for two days, alternating with a 3½-fold operation every third day. This was the best utilization of an equipment that had yet been seen. It was made possible, no doubt, because of the fact that the Bavarian distillers were favored with a relatively high "Kontingent" in order to get them to cooperate with the distillers of the northern States and Provinces. Of this the northern distillers constantly complained. Besides, in the distribution of the "Kontingent" every five years the 36 farmers belonging to the cooperative plant naturally exercised a greater influence collectively than if each one were fighting for himself and against his 35 neighbors. The yield of alcohol averaged 12 per cent, and the spirits obtained averaged 90 per cent.

Owing to a variety of circumstances, such as improvements, the low price of alcohol, etc., the company paid no cash dividends that year. Each farmer, however, had received his spent mash, which was valued at 2.7 cents per gallon. The farmers also received 1.2 cents more per bushel for their potatoes than did the outsiders. If potatoes gave out they could use maize, of which the distillery had

used in one year as much as 80 carloads of 393 bushels of 56 pounds each. It was expected that they would use only about 30 carloads in 1907, partly because of the good crop of potatoes and partly because of the high price of Roumanian corn. This corn, which is said to be richer in starch than the American La Plata corn, had formerly cost but $1.30 per 100 pounds, but at that time the price was $1.83 per 100 pounds. This increase was partly due to an increase of 71.5 cents in the duty on foreign maize.

If, as stated by the superintendent, the dividends had been only as high as 4 per cent in good years, the high value of the stocks could be explained only by the value placed on the spent mash.

The superintendent of such a distillery, as may be expected, is a very different sort of man from those found in the distilleries which are hand equipped or even in the medium steam-operated plants. As has been pointed out, the larger distilleries are taxed much more heavily, and in order to obtain the same returns on the investment they must be operated much more economically and must produce a larger percentage of alcohol.

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